
# Oral History of Fumitake Shiraishi

Interviewed by:
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**Yamashita:** This oral history interview is with Fumitake Shiraishi, who is credited with designing Toshiba's successful lines of small form factor drives. In particular, he played a leading role in the development of the drives using glass media, first introduced in 1991, which propelled Toshiba to become the dominant player in the 2 ½-inch drive market for a considerable amount of time. Mr. Shiraishi obtained a Mechanical Engineering degree from Kyoto University and entered Toshiba in 1966 in their Electronic Computer Division. He initially worked on tape drive development, but quickly joined the HDD development group at Toshiba starting in 1967, and he worked continuously in the HDD development until his retirement from the company in 1996. He was involved in large 14-inch IBM compatible HDD development initially, and went on to be involved in all subsequent HDD development at Toshiba, contributing to over 40 products during his illustrious career.

In 1998, Mr. Shiraishi joined Hoya Corporation, and served as the General Manager of their Glass Media business until 2002. After that, he continued to work for Hoya Corporation as their Staff Senior Technologist to support the glass media business until his retirement in 2007.

This interview is under the auspices of the Computer History Museum in Mt. View, California, and the interview is being conducted at the Hoya Corporation MD Division office in Shinjuku, Japan. We would like to thank Hoya Corporation for providing us the space to hold this interview.

The interview will be conducted by myself, Tom Yamashita, and Isao Suzuki.

**Suzuki:** [Mr. Suzuki repeated the same introduction in Japanese]

**Yamashita:** First of all, Mr. Shiraishi, thank you very much for agreeing to this interview. It is very much appreciated. Please tell us first, your [full] name, where you were born, and where you were raised.

**Shiraishi:** My name is Fumitake Shiraishi. I was born and raised in Ehime Prefecture, on the Shikoku Island in Japan.

**Suzuki:** Please tell us the school that you graduated from, your major, and the field of interest.

**Shiraishi:** I graduated from Kyoto University, from their mechanical engineering department. The theme of my thesis at the time of my graduation was related to deformation processing of powder [metallurgical] molding parts. At that time, powder molding was taken up as new area of investigation in the field of deformation processing, and I took interest in this topic and I conducted fundamental research in this area.

**Yamashita:** Can you tell us a short [version] of your professional career?

**Shiraishi:** Yes, after graduation from college, I joined Toshiba in 1966, in their Electronic Computer Business Division. My first job was to work on MT or Magnetic Tape equipment development, but this project was shut down and in 1967, I moved to the HDD development project. This was my first encounter with HDD. Since then, until I retired from Toshiba in 1996, I was involved in the development of HDD technology throughout. During this time, I was involved in all the HDD activities [at Toshiba], which was probably over 40 different models of HDD. My role involved various positions, as a lead engineer, chief engineer, manager and so on, [taking charge of entire drive development projects]. After retirement from Toshiba, I joined a Toshiba affiliated company called TCOT as a director of technology but after about 9 months on this job, I quit. After that in 1998, I joined Hoya Corp. and I became the head of their glass

  

media business as their General Manager. From 2003, I became a "Senior Technology Staff" for the company and supported the media business in that capacity. In 2007, I retired [from Hoya].

**Suzuki:** At university or initially at work, are there people that affected you or made an impact on you, or things that happened that you can talk about?

**Shiraishi:** The first person that comes to mind is Professor Oyane[1] at the University. He taught me that when you challenge [yourself] in a new field, you must first gather fundamental experimental data, and build this up, then you must explain this in a clear theoretical way. He taught me the importance of this method.

For the second person was Kanai Kacho (Kacho means manager), who managed and provided guidance to me when I joined Toshiba and worked on IBM model 2311 and 3300 Model 11 [compatible] HDD development. He was a superb mechanical engineer. As a young engineer, he taught me how fundamentals of how to write, read and check mechanical drawings, and later, taught me the practical aspects of mechanical design. In addition, he also taught me how to challenge myself into trying new things, so-called "challenge spirit" to take on challenging topics onto yourself. One example of this was when we were developing the IBM 2314 type HDD, we started to use a voice coil actuator. At that time IBM used a hydraulic actuator, and we were able to achieve much faster access times with ours. We were probably the first ones to try using voice coil actuator at that time, but the mechanism was being made in USA by a company called Infomag. As a result, I was ordered to go to US, and discuss specs with them, this was in 1970, I believe, and it was my first overseas business trip experience.

For the third person, this would be Mr. Shirai, who was the chief engineer in the Electronic Computer Division. Mr. Shirai is the one that decided to export Toshiba's HDD overseas. Around 1977, we were progressing on technical alliance discussion with a company called Diablo in USA. This discussion broke up, but immediately afterwards, we started an OEM business relationship discussion with USA Ampex Corporation. During that time period, we took Toshiba's HDD to US and conducted demos, and held technical discussions/explanations several times. During that time, Shirai-san told me strongly to have confidence in the HDD that you built, and make presentations from that standpoint. The Ampex discussions came to fruition and we embarked on an OEM business with Ampex. Mr. Shirai's direction, to be confident in your new equipment, your development efforts, and the new product, became very useful strategy to follow.

**Yamashita:** How was this [equipment] used or intended for at Ampex?

**Shiraishi:** Actually, Ampex was making their own HDD. They requested us to develop an HDD that they were not making themselves. However, as a background to this story, I talked about Diablo relationship, and there was a member of Diablo team that went over to Ampex when Diablo project was cancelled. Basically, that is how Ampex called on us.

**Yamashita:** When did Toshiba begin their HDD business, and what was the background for that? What were their early products and transition from that? Can you also talk about [their] success and failures?

**Shiraishi:** I will talk about the time that I was with Toshiba, about their HDD [programs] from 1966 to 1996. In 1966, they had their in-house developed computer system, and they started to develop an IBM

[1] Professor Moriya Oyane, Kyoto University, Mechanical Engineering Department.

  

2311 type HDD to use for external memory device. For this system, it was necessary to have compatibility with 2311 type disk pack, therefore we procured an IBM unit to serve as example to develop our own. It took about 3 years to develop. When we first shipped this product, it was 1969, so it took a long time. As for myself, I was responsible for developing the hydraulic actuator. After this, we developed IBM 2314, 3300 model 1, model 11 compatible equipment in similar fashion. These units were employed in the internal computer system. Around that time, I became responsible for the design of the [HDD] system. Around 1976, we developed the first fixed disk – Winchester type disk drive. These products were used in internally developed office computers and word processing machine. During the development of these machines, I started to become the overall responsible person for putting together the entire machine. One of the biggest changes that came after this period was the Ampex OEM business that started in 1979. What Ampex wanted from us was to develop a dual access HDD. What we developed was a system that combined the features of cartridge type HDD with the fixed drive HDD, which had a unique dual access capability. We supplied this machine to Ampex and we ran into various issues with it. Every time we had trouble, I was called to US, to try to fix the problem. Sometime a week trip turned into a month long stay several times. This system was something that I was proud of creating, but at the same time, it was a machine that caused some suffering for me. After this period, Toshiba went with the push to smaller form factor that HDD industry was on, and we developed 8-inch, 5-inch and 3.5-inch form factor HDDs. However, the scale of our operation was relatively small, and we fell into considerable hard times. Then the thing that turned it around was the 2.5-inch HDD series that went into production from 1991. Within this series, the 3rd model, the M130 which had the 130 Mbyte capacity, was a big hit. This model dramatically improved the profit/loss picture of the business, and became the legendary lore that was to be talked about at Toshiba for the turnaround of the HDD business. This was the spark, and we developed one after the other, many highest capacity models and we became the industry leader in this segment. The HDD that I first worked on, to develop, was IBM 2311 [compatible] type drive, and it had the capacity of 7.25 Mbyte. The last drive I developed at Toshiba was M3000 model, a 2.5-inch HDD with the capacity of 3.3 Gbyte. It means that the capacity increased 450 times during that time. Even after my retirement in 1996, Toshiba continued to lead the industry with the 2.5-inch, 1.8-inch and 0.85-inch drives, and the continuation of miniaturization and increase in drive capacity.

**Suzuki:** So, how about for yourself, Shiraishi-san, can you talk about examples of your own success and failures? What would be something that you are most proud of?

**Shiraishi:** As for myself, that would be the success of the 2.5-inch HDD development that I just talked about, the fact that this made Toshiba HDD business profitable, and that I was able to contribute to it. For someone that works on product development, the most important thing is to keep to the schedule. Falling behind on the schedule means that you are losing to your rivals, and it would cause your business to lose money. So, what I think I can be proud of is that I was able to develop new models one after another, keeping all of them more or less to the schedule, and I was also fortunate to be able to have good members in my team. As for failures [mishaps], this is something that goes with the territory when you are developing something new, a leading-edge product. One example that I can give, one time we developed a brand-new swing-arm type actuator for a fixed drive, and we used a leading-edge testing equipment to test the mechanism. Once we started the test, after only about a week, the mechanism started to fail. It was because the bearing that we used in the shaft had failed. We went to the bearing vendor to explain the situation, and what we were told was that, “Shiraishi-san, this bearing is designed for something that rotates…”. In another word, it wasn’t designed for something that only moves within some fixed angle. Such use was never foreseen for the bearing. We then had to provide a new spec where the bearing will only move within few tens of degrees and we had the bearing maker develop a new bearing for that purpose. So, it was new grease, the amount that can be used, amount of pressure it

  

can take and so on. All of this had to be developed specifically for our new application. This then served a useful purpose on all of our later drives, starting from our 8-inch drive.

**Yamashita:** Did you develop the lubricant [for the bearing] yourselves, or by the vendor?

**Shiraishi:** The vendor developed the lubricant.

**Yamashita:** How about the testing, was that done together too?

**Shiraishi:** The testing was conducted by us.

**Yamashita:** What was Toshiba's motivation for developing the 2.5-inch HDD? What market were they after, and who were the competition? And what was the reason for Toshiba's success?

**Shiraishi:** So, I will talk about the development of 2.5-inch drive, and its background, what was happening at the time. I think it was around early 1989, the management at the very top of the business issued an order that HDD business must improve its profit and loss situation. We were told to develop a new business plan. Also, in 1989, the PC division of the Toshiba introduced a notebook PC, it was called the Dynabook Series, they had just gone through a world debut for this product. However, the drive that they used inside was made by Conner [Peripherals], it was a 2.5-inch HDD with 20 Mbyte capacity. Using this as a hint, we had various information exchange with the PC division, and we forecasted that the mobile market, represented by the introduction of this notebook PC will grow strongly in the future. So, if this is the case, we should just focus on this market and put our bet on this market, and made our business plan based on making 2.5-inch drives. Conner was already in the 2.5-inch market, and made our own PC division the biggest customer, we made them our biggest target. Since we were already behind Conner with their 20 Mbyte drive, so we decided to put our target on developing a drive with twice the capacity at 40 Mbyte and proposed this to our PC division. With that, we started our drive development activity. I picked up engineers for this purpose and formed a team. The problem was that the development schedule was very tight. We started the development project in October 1989, and first sample by December 1990, production start in April 1991, this was all decided ahead of time. So, we started the development activity, and somehow, we managed to keep to this schedule, and we were able to successfully start the production of M40 model. Thereafter, we introduced new models one after the other. In April of 1992, we took a lead over the rival company with the introduction of M130 with 130 Mbyte capacity. This model became a big hit for us. However, there is a story behind this one, which is that our rival, who was actually Conner, had already announced a 126 Mbyte model, but they must have had some manufacturing issue, and nothing had come out. So, we were the only one with this capacity point in the market. We were in a situation where we can sell everything that we could make, and it had a big impact on our bottom line. With this as momentum change, we introduced two to four new models each year for a while and became the leading company in the 2.5-inch mobile HDD market. As examples, I can list the following drives. Starting in April '92….. (short break)

If I list the drives which we led the industry in,
1992 April, 130 Mbyte (model M130)
1992 October, 214 Mbyte (model M200)
1993 May, 340 Mbyte (model M300)
1993 December, 520 Mbyte (model M500)
1994 November, 720 Mbyte (model M700)
1995 May, 1200 Mbyte (model M1200)
1996, December, 3300 Mbyte (model M3000)

  

We released the new products in such a pace.

**Yamashita:** Were you able to keep to the schedule on all of these drive programs?

**Shiraishi:** Yes, we were able to keep to the schedule in nearly all of them.

**Yamashita:** Is that so.

**Shiraishi:** If I can be proud of something, this will be it. Another thing that allowed us to mass manufacture all of these drives, is that from 1992, we stopped working on all other form factors, and concentrated strictly on 2.5-inch drives. This was the strategy that allowed us to succeed. Even after these drives [mentioned already], our small form factor strategy continued.

**Suzuki:** What were some of the challenges and topics for pursuing this strategy?

**Shiraishi:** It would be that Toshiba did not make any of the key components ourselves. The key big topic for developing industry leading product for us was to decide which key vendor we will use for the key components. Some of the key basis or ground-rules for deciding which vendors to use, was its performance, of course its quality, and whether the vendor possessed the technical capability for solving problems if it occurred. And, whether their key engineers had the mindset or passion in their work. Also, whether the company was serious enough in their business, whether they possessed enough money [ or financial means] and so on. So, we based our selection criteria based on these factors. In order to manufacture in volume, the key parts were the head and media. So, the key vendors we selected for heads was Yamaha and the media was Hoya. However, the biggest risk factor for this selection was that both the vendors had no manufacturing experience at all for these parts. In order to address this issue, we made our own development plan and our business plans completely open [to them]. In so doing, they created their plan that matched ours and we were able to get their agreement to go forth with their plan. I think the reason for our success was that we were able to have such good relationship with our vendors.

**Yamashita:** This [still] seems like a big gamble…

**Shiraishi:** It was. A big gamble.

**Yamashita:** So, you did indeed feel that it was a big gamble?

**Shiraishi:** Indeed, we felt it was, but we also did not have such a large manufacturing experience either, for HDD. And, as a component manufacturer, both Hoya and Yamaha did not have any experience base [or credibility] as a manufacturer. We thought that if we are going to die, at least we will die together. We went forward with it, prepared with that sort of mindset.

**Yamashita:** Can you talk about the development of your first glass media based 2.5-inch drive? What was the reason for choosing glass media, and how did you solve the problems associated with using it?

**Shiraishi:** As for the 2.5-inch [glass-based] drive, as I mentioned previously, we started on this in ’89 October. At that time, Conner [Peripherals] was already shipping 20 Mbyte drive with aluminum media, using one platter. So, for ourselves, we decided in a rather simple-minded manner, that we will do 40 Mbyte with one platter and set our development plan. However, it’s one thing to set your plan, but achieving it was another matter, and we had to get 100 Mb/in$^2$ recording density to achieve this. We knew

  

that going into the plan beforehand. The highest performing head at the time was a 50-turn thin film head, and we decided on that, and thought that we could use a glass media with very low surface roughness and superior surface smoothness, combine this with the 50-turn head and fly lower. We calculated that we can achieve our recording density goal by flying lower than 0.1 micron. So, with that, we decided on Yamaha's 50-turn thin film head, and Hoya's glass media and we formed a 3-way partnership development team between the companies and started on this project. We worried however, that glass media would be susceptible to break and chip, as people were always saying before. We decided that we needed to test these parameters, and we built various experimental testing equipment to get the data with the glass media. We tested them using vibration test, impact test and drop test for example. We repeated these tests many times, which were quite harsh, and we tested it together with aluminum media to compare the results. What we realized then, was that impact resistance using glass media was far superior to using aluminum. There was an impact resistance spec of 100G that was around then, and we were able to far surpass it, easily pass the spec using glass media. At later time, this became a big selling point for our drives.

Another thing, Hoya for their glass media had this special feature, which was an overcoat using $SiO_2$. This feature for our development plan was quite big, it had superior performances on 4 things [that were important] for the drive reliability. They were 1) head disk interference, or HDI, related to head crashes, 2) for CSS or contact start-stop, 3) for anti-stiction and 4) for corrosion resistance. Hoya media with this $SiO_2$ overcoat cleared all our spec on these parameters.

However, Hoya's glass media had 2 major issues. First is that glass media, the thermal expansion coefficient is much smaller compared to aluminum media, and we could not use the aluminum hub that we were using previously. This is because the difference in thermal expansion coefficient would cause the glass media to warp. To solve this issue, we had to use a metal that is much closer to the thermal expansion coefficient of glass and we chose to use a hub made from stainless steel. The vendor that we went to, to have a spindle motor using stainless steel hub was Nidec. They developed a new spindle motor for us. By doing this, we were able to reduce the warpage problem to a minimum using glass media. However…

**Yamashita:** By using this stainless steel, did you encounter other problems like it being heavier, or more expensive for example?

**Shiraishi:** This is the case, but frankly speaking, there are advantages to using stainless steel, for the magnetic circuit design inside of the motor. If using aluminum hub, you must put in some steel inside the hub [for the magnetic circuit]. There is a stainless steel with magnetic characteristics, and we used that type of stainless steel. In so doing, things got simpler, there was merit to this for Nidec as well. Other companies later followed suit for this reason. Then the second problem for glass media was something that was exclusive to glass, which was that at the OD (outside diameter) of the media, there was a ski-jump (a protrusion) which caused instabilities in flying characteristics of the head. We asked Hoya to improve or reduce this on their media. At Hoya, they did things like improve the polishing pad material during substrate processing, and they worked on various other improvements to their process. So, they were just … actually it would not be proper to say "just" but they were able to get the media to meet the specification and with that, we were able to start using glass media on our HDD. Besides the glass media, we also used the latest technology and components at that time into our drive. I mentioned the 50-turn thin film head, sensor-less spindle motor using stainless steel hub, voice coil motor using Nd magnets, 1,7 RLL coding and digital servo, amongst others.

  

**Suzuki:** You have worked on the design of variety of HDDs, and from your viewpoint as a mechanical engineer, what do you consider to be the most important, critical and what you watched over in the design of the HDD?

**Shiraishi:** It is really the baseplate. HDD is a typical precision machine, and as such, for the precision parts and machinery that are mounted on the baseplate, the baseplate becomes the key to the entire machine. It supports all the components, and its strength, robustness, and especially the warpage [ or stability] when subjected to temperature changes, how the part is designed to minimize it are all really important. There is one good example where it was very successful, and it was used in the 2.5-inch drive which is the box-type[2] baseplate. When you use box—type baseplate, it becomes more difficult when you build the drive, and manufacturing [side] complains that manufacturability is worse, and they opposed it. However, using it improves the stability of the performance and brings out the best performance, therefore we chose to use it. And this design was used continuously for a long time. I believe personally that it was one of the hidden reasons why the miniaturization of the drive was so successful for us.

**Yamashita:** Changing the subject, can you talk about 5.25-inch and 3.5-inch drive development, some topics regarding them, and whether these products were for internal Toshiba use, or intended for external customers? Which was it?

**Shiraishi:** For us, 8-inch drive before 5.25-inch, the 8-inch, 5.25-inch and 3.5-drive, were all "follower" drives, or products that were behind others. So, developing drives that were behind others was the norm for a long time. Nevertheless, we continued to develop new drives somehow, and continued to manufacture them. Basically, they were mainly intended for sales outside of Toshiba. Only about 25% of the volume went for internal Toshiba use.

**Suzuki:** I think Toshiba [as a company] along with NEC was very successful in portable, notebook and regular PC market in Japan and in the world. Was Toshiba PC business used internally produced HDD, or using outside vendors? In addition, how was the HDD business success related to the success of the Notebook PC business?

**Shiraishi:** The Toshiba's PC division was the first to introduce Laptop PC in 1986. Following that, they introduced Notebook PC as a Dynabook Series [of products], and they debuted this line into the world in 1989. They had tremendous growth, and they were also succeeding as a business. However, these products, both Laptop and Notebooks used externally produced HDD, they were American companies. They were using 3.5 and 2.5-inch drives. We [HDD Division] was not making any HDD intended for the mobile market. They did not use our drives until 1991 with M40 model 2.5-inch HDD, with 40 Mbyte capacity, that was the first time. In 1992, we became the first [or primary] vendor, and as I mentioned, it was with the 130 Mbyte model and it was also because the other vendor could not deliver, and they used everything that we made.

**Yamashita:** They [PC division] weren't required to use your HDD? Get preference?

**Shiraishi:** There were none of that, external, internal, they were all treated the same, [we] had to compete…

**Yamashita:** That is strict…

[2] In Japanese, the box type baseplate is referred as "bento-bako", or literally lunch-box because it is shaped like the lunch box often used in Japan.

  

**Shiraishi:** Yes, it was strict.

**Suzuki:** For the internal business, what % of the business was internal, for example for the 2.5-inch HDD? How did you manage the marketing for internal vs. external customers?

**Shiraishi:** Selling the 2.5-inch drive internally began in 1991, and for 1991 and 1992, it was around 70% for internal use. For 1993, probably around 45%, and thereafter, it was 40%, 35%, 30%, it gradually became less. Before 1992, we sold to the PC division, and external was only to the Japan PC manufacturers. From 1993, we added American and Taiwan markets, and from 1994, we expanded to worldwide. As this happened, the % of the products going to internal PC customer decreased. HDD sale/marketing is "proposal type", meaning that we gather various information from various customers, and HDD manufacturer themselves develop a new model and sell them to the PC makers. The game was to sell before anyone else, and capture the market before anyone else. That was the competition. It is because the interface for the HDD is common, so the competition for developing new product was whether the HDD capacity was bigger or not, its performance, and whether the device is thinner for example, it was that sort of competition. Therefore, it was whether your new product could be used by your customers, we treated the internal customer the same as external ones. We also gathered our information from everywhere.

**Yamashita:** Did you vary or change the type of drive you sold to each customer?

**Shiraishi:** We did not do much customization. We still had to manufacture them in volume, and in the HDD [market], you propose your new product, get your customer to use it, [and] have the product match the customer need.

**Yamashita:** Is that so?

**Shiraishi:** It is.

**Yamashita:** When did Toshiba change from Ferrite and MiG heads to thin film heads, and when you changed to thin film, were there issues (topics) that you can discuss? And where did you obtain the thin film heads from?

**Shiraishi:** The first thin film heads we started to use was in 1991, with the 2.5-inch M40 model. As for the MiG heads, during that time we were using TDK and Kyushu Matsushita or KME. As for thin film heads, use obtained samples from Dastek, AMC, TDK and Yamaha and evaluated their performance. At the end, we picked Yamaha's 50-turn head. As for the reason, it was because they had the best performance.

**Suzuki:** So then, were there some challenges that you encountered when you started to use MR heads for the first time? When and where did you obtain the MR heads?

**Shiraishi:** Let's see, when we started to use MR heads for the first time in the drive during the development, the first thing that we had to confront was dealing with TA, or thermal asperities. In order to reduce them, first thing was to come up with a strategy on small contamination (to reduce them), and have Hoya do the testing evaluations. Besides the media, for other components, we strengthened the measures taken toward contamination reduction. We also took measures to reduce the incidence rate of TA's. At the same time, we used TA correction signal processing measures. The first drive using the MR

  

head was the MV1200 model introduced in 1995, this head was obtained from TDK. Then starting from MV2000 model introduced in 1996, we started to use dual-stripe MR head, the DSMR head from Headway.

**Yamashita:** Changing the subject again, how did Toshiba manage the implementation of PRML channel? Did you develop this internally, and is there some topic that you can discuss on this subject?

**Shiraishi:** We started to use PRML channel staring in MV340 model introduced in 1994. We used the PRML channel [chip] developed by an American company, DataPath System[3] For us, this was a joint development activity with them, therefore all the chips were procured through them. I do not recall any particular problem regarding the use of PRML.

**Suzuki:** This is regarding the use of glass media with isotropic surface, it would be that this will have inferior magnetic performance compared to the aluminum media having preferred orientation (of its magnetic grains). Did this cause problems for you during development?

**Shiraishi:** Around 1992, we were evaluating the oriented aluminum media. However, for us, having the impact resistance was an important factor for the HDD in the mobile application, therefore we kept sticking with glass as it was much stronger. In order to increase the areal density, we made use of the smoothness of the glass by reducing the flying height and reducing the spacing loss as means of addressing this issue, that is increasing the areal density, therefore we kept gradually reducing the flying height. Of course, to do this, the head is also a factor, and we used for example, TPC type head, this is Transverse Pressurized Contour type head proposed by Dr. White[4]. We also actively adopted such type of technologies, including negative pressure head. By doing this, we designed for reducing the flying height. It was not only just flying lower, making it constant was something that we also tried to design in. We also actively implemented miniaturization of the head, from 50% to 30%, and as for the media, we also made it thinner and we implemented 25 mil thick glass media before anyone else.

**Yamashita:** So, by using glass media, you were flying much lower than anyone else, did this cause any problems for you?

**Shiraishi:** As I mentioned, this is related to the head also, if the head is stable, and if one can make the surface roughness lower, you can lower the flying height. Therefore, the TPC type head is designed to fly constant despite the roughness change, but having the constant flying height allowed lowering the flying height. So, by using this along with lowering the roughness of the media, we were probably flying 0.1 to 0.15[5] microns lower than other manufacturers.

**Yamashita:** Is that why (simultaneously speaking) you were able to compete without (having oriented aluminum media?)

**Shiraishi:** That is right.

**Yamashita:** After you retired from Toshiba, you moved to Hoya. Can you talk about your work and position at Hoya?

[3] DataPath Systems Inc., acquired by LSI Logic in 2000.
[4] James W. White, Transverse and Negative Pressure Contour Gas Bearing Slider, USP 5404256
[5] The number was misstated, it should be 0.01 to 0.015 microns.

  

**Shiraishi:** Yes, I joined Hoya in 1998. So, until 2002, I was the GM of their Glass Media Business unit. During this time period, we had the IBM 1-inch HDD business, although it was a very small business for us. This experience left a strong impression on me. As for the reason, we were (driven hard), and we could not deliver the quantity that they needed, and I remember that they were very hard on us. From 2003, I became a Senior Technical Staff and I continued to support the entire media business. Then in 2007, I retired (from Hoya).

**Suzuki:** I like to change the type of questions now, for yourself, is there some particular patent for example that is your favorite, and also some awards that you were recognized for?

**Shiraishi:** I do have quite a few patents and disclosures, probably around 50 to 60 in total, but the one that have a lasting impression on me is a CMD, Cartridge Module Drive patent. This is also granted in in the US in 1983 at the USPTO. What this CMD is all about is that it is a very unique drive that combines interchangeable cartridge with sealed module. So, the baseplate that combines these two functionalities has on top the cartridge and the access port that access it, and on the bottom, there was a sealed module with Winchester head, media and actuator. As such, it was very unique and also very complicated drive. The unique feature of this drive was that the cartridge module and the sealed module can access the data simultaneously. As I discussed previously, this was what Ampex asked us to do. I had thought that this is impossible, but this was what we proposed as a mechanism for them.

**Yamashita:** So, this is what you feel proud of as a mechanical engineer…

**Shiraishi:** I think it was because there was nothing like it in the world at the time. And, there will never be anything like it again (laugh). As for the awards, I received in 1994 an award called Japan Society of Mechanical Engineers Award[6], [JSME] for my work on M300 model 2.5-inch HDD having 340 Mbyte capacity. As a Japanese mechanical engineer, this award was something that I was very pleased to receive.

**Yamashita:** Were you involved in Japanese University relationships or in activities such as SRC (Storage Research Consortium)?

**Shiraishi:** I was one of the founding members of the SRC[7] (consortium). I headed their mechanical group. Also, I was a member of the standards committee for the Japan Electronics Industry Development Association (JEIDA)[8]. In this organization, I worked on establishing a Japanese standard for IBM 2311, 2314 type disk pack.

**Suzuki:** The storage industry has big ups and down, and today in Japan, Toshiba is only one left (of the drive companies). How is it that Toshiba survived?

**Shiraishi:** At Toshiba, we had this company policy called “choice and concentration”. For our HDD Division, it was the choosing the mobile market, and concentrated on its miniaturization. That was our choice and concentration. I believe that having done that was the big reason for our survival. Also, within our HDD Division, we had this company motto, called “Sei-Han-Gi-Ittai”, it literally means manufacturing, marketing, and technology are one body. This instilled very strong sense of solidarity within the entire organization. So, we had this sort of background to having weathered through difficulties. Another viewpoint might be that within Toshiba, we had this PC Division, which was for the HDD division the biggest customer. This was after all, one of the biggest reasons for our success. However, my own

[6] JSME (Japan Society of Mechanical Engineers), 1993 Japan Society of Mechanical Engineers Award (Technology Award), Large Capacity Miniature Magnetic Disk Drive Development.
[7] SRC, Storage Research Consortium, group formed to advance storage technology in Japan.
[8] Japan Electronics Industry Development Association (JEIDA), established in 1958. In November 2000, it merged with Electronics Industry Association of Japan (EIAJ) to form Japan Electronics and Information and Technology Industries Association (JEITA).

  

personal belief is the fact that HDD Division did not make their own key components, and that it specialized on bringing it all together instead, I think this is one of the hidden reasons for the success.

**Yamashita:** What do you think of the future of storage industry? Would the disk storage continue its importance? What do you think about some of the newer technology [in the HDD]?

**Shiraishi:** I believe that so-called Big Data, the necessity of storage for it, will make storage grow continuously in the future. Within this context, it has been said from the past that semiconductor storage will surpass and replace HDD, but HDD is still fighting, and I think it will still take a long time for this to happen. It means that HDD will continue to be an important storage device and this will not change. There are new technologies such as HAMR in HDD, but personally, I think it will still take some time.

**Suzuki:** For computing, what do you think will become important? And for storage, what will it mean?

**Shiraishi:** Technologically speaking, I think the most important thing is increasing the processing speed for computing. I think the quantum computing is becoming a strong candidate for this. On the other hand, things like IoT and AI continue to develop. Therefore, the amount of information needed will never be reduced. It will continue to increase further, and it will increase further than our expectation. Therefore, the increasing processing speed and increasing storage goes hand in hand. It is like the two side of the car wheel, you need both. The necessity for storage will continue.

**Yamashita:** Is there anyone that made the biggest impression on you while you were involved in HDD development?

**Shiraishi:** There is one person, that would be the Chairman of Nidec, Mr. Nagamori. We had relationship with Nidec as spindle motor vendor since 8-inch HDD days. I have heard that Mr. Nagamori founded Nidec on the idea that they will work on anything that rotates. And I have heard him say that if it rotates, we will bring it on. And his motto, though simplified, is “do it right away, will always do it, and work on it until it is done” and instilled this into his employees in a very thorough fashion. Perhaps because of this, Nidec has become number 1 in HDD spindle motors, but not only in this field, they have moved into automobiles, household appliances and so on, and they are now the top motor manufacturer in the world. I am impressed by the fact that his commitment or being very particular about “anything that rotates”, and his strength in that commitment and his ability to execute has netted fruit. Another example of just how particular he is, I heard that he recently built a house in Kyoto, and the house was constructed without the single use of nails. When talking to him, the thing that I remember the most, is just how committed and passionate he is toward work, and he talks like this also, and this is something that I strongly empathized with, that to do any work, you must have passion for it.

**Yamashita:** When you started to have a relationship with Nidec, did you have other competitors besides Nidec?

**Shiraishi:** During those days, or perhaps it was a little later, Minebea might have been a competitor. There were other motor manufacturers, but there were not so many spindle-makers. In Japan, it was really only Nidec. In the US, many companies like Seagate were making their own.

**Yamashita**: Yes, many were making their own then. Since using Nidec, I guess both (you and Nidec) succeeded immensely.

**Shiraishi:** Yes, Nidec was, shall I say, very good at using their own customers (laugh). For example, if there were some problems with their motor, they would try to solve the problem together with the customers. If something happened with Toshiba for example, Toshiba engineers would go to Nidec and they will solve the problems together. That way, we were used (by them). They put a lot of value in customer relationships.

**Suzuki:** Were there any interesting experience that you can tell us while you were working?

  

**Shiraishi:** Yes, there is one story which I would like to tell. I think it was during the 1995 summer, one of the 2.5-drive that came back from a customer with the claim of a failure, and the guy in charge of examining the failure reported that he found a dead ant inside the drive. We have never heard of such thing before, and we wondered from where the ant could have gotten inside of the drive. Upon analysis, we found out that the ant had broken through the small filter cover seal that was on the top cover. The guy in charge of the issue then found a professor that specialized in ant research, and we went to see him. So, we told the professor about our problem, and asked him how or why did the ant went inside the drive when there is no food or smell to attract it there? To this the professor immediately replied, "listen, ants have a lot of spare time, and that is why they are wondering about all over the place. And also, they really love small depression on an otherwise smooth surface". I was really surprised [and taken back] by his response, it never occurred to me that ants might have "spare time". Since then whenever I see ants wondering about in my garden at home, I think to myself, " ahh, these guys must have spare time…" But whether the ants really have spare time or not is something I guess you have to ask them. I think they are probably just working very hard.

**Yamashita:** I have never heard of such a thing either, but did you take any action after this incident, like changing the depression on the cover plate?

**Shiraishi:** To tell you the truth, we did, we flipped the cover plate, that is, the filter got put on the top of the plate so that instead of being a depression, it became a protrusion. We never heard of an ant getting inside the drive ever again (laugh).

**Yamashita:** We are now nearing the end of the interview, if you were to give an advice to a young engineer, what would that be?

**Shiraishi:** So, let me see, I think for a young engineer, a technologist, I think the most important thing still, is to possess a core technology for yourself. Then to polish that and become top in that field, to make an effort toward that end. Then another thing is to go challenge yourself into a new thing, it can be anything. I also talked about Nidec, but it is very important to tackle the work with a passion. To be a true professional, I think you have to be someone that can set a goal for yourself and with effort be able to achieve it in your field.

**Suzuki:** We would like to conclude the interview now, is there anything that you would like to add?

**Shiraishi:** I have been involved in the HDD field for a long time, on advancement of HDD, and if I was able to make even a small contribution to that end, it was because I had received big contributions from my colleagues at Toshiba and also from our vendors. I would like to thank everyone for that. At the same time, I hope that HDD continues to develop further. Thank you very much for today.

**Yamashita and Suzuki:** Thank you very much.

END OF THE INTERVIEW

  